determine whether it is equal to zero. If so, control passes to block 1237 in which the start cage routine is called. If not, control passes to block 1239 in which the forecasted cage position is calculated. In accordance with block 1241, the cage controller is loaded with a forecast position. Control then passes to block 1243.

APPENDIX 1

Objective

This procedure is intended to provide instruction on how to setup the automatic cage controller option that can be installed on color touch screen system that also have the layflat controller.

Function

This is an overview of the generic function of the system.

The cage controller must be in the AUTO CAGE mode before any size changes are made to the system. If the system is in MANUAL CAGE when a size change is made, the cage will not move even when placed into AUTO CAGE. When in AUTO CAGE, the following actions will cause the cage to move:

1. Entering a new target size: size change can be as small as 0.01 inches
2. Entering a new actual size: size change can be as small as 0.01 inches
3. Enter a new cage contact value: change has to be at least 0.05 inches (see parameter 46 in Cage Controller Parameters screen).
4. Operator operates the manual cage close or open push buttons

The cage controller uses a dual mode process of sizing the bubble. Depending on how large the size change request is, the system will use one or both modes to position the cage to the proper size. The first mode is called the FORECAST mode. This mode is used when size changes are greater than the ½ the layflat controller window (generally about 2 inches) and during startup of the bubble. The forecast mode provides an estimate of the final layflat before the bubble gets up to size. With this information, the system can pre-size the cage to the proper position. See Figure 45.

During the startup process of the bubble, the system will start in forecast mode. Under these conditions, forecast mode receives information from the IBC sensor that is generally less stable than the information that comes from the layflat sensors. This can cause temporary miscues in the cage movements during the time of greatest instability. As stability improves, the cage will correct itself and continue making the movements to the correct size. To minimize the chance of a miscalculation during forecast mode, the system makes several checks to ensure all sensor signals are stable. For instance, if the IBC system loses echo, the forecast calculations cannot be made and the Cage Controller is paused. When echo returns and IBC filtering has returned to normal speed, the cage controller resumes normal operation. A similar process is exercised on the layflat sensors.

After forecast mode is complete, contact mode starts. If the size change was less than ½ the layflat controller window, then contact mode is the only mode used. The purpose of contact mode is to produce fine movements of the cage and to take into account the final cage contact value. The contact mode executes on a much slower cycle than forecast mode to ensure size changes are achieved with a minimum of overshoot. Below is a picture of a size change as viewed on the roll of wound film. Notice the size change from 61 inches to 41 inches makes a smooth telescope effect on the roll. If the process produces a stair step effect, then the process is too slow. The extra small section of film extending back was due to an operator making adjustments on the winder. See Figure 46.

Procedure

1. Turn off the Cage Controller and commission first the IBC system, then the Layflat Controller. It is important that the IBC and layflat controllers are working properly before attempting to commission the cage controller

Set the basic parameters based on the sizing cage you are commissioning:

Egan Cages with Speed Adjust Pot

Set Speed Pot to 50% - Located in the Contactor Panel, note that if you have problems with the system not quite reaching size. Increase the speed of the cage with this pot. Some cages have significantly slow cage speeds. Set these cages to 75% of maximum. If size overshoot is continually a problem, reduce the cage speed.

Set Parameter 40 to 0.2, P41 to 5.0, P42 to 0.15, P45 to 0.25, P46 to 0.05, P47 to 0.6

Gloucester Cages

Set Parameter 40 to 0.1, P41 to 5.0, P42 to 0.15, P45 to 0.25, P46 to 0.05, P47 to 0.6

Kiefel Scissor Cages

Note Scissor cages do have variable speed. The cage moves quite quickly when opened fully and moves slower when closed fully. This is not a problem for the system. However, the larger variety of cages may need to have a slightly larger P47 than the smaller cages. If the cage is moved using a variable speed drive, then check the electrical prints for a speed control circuit connected to the manual push buttons. This circuit provides a faster speed when the push buttons are used. Change the circuit so the high-speed operation is used all the time. Next in the drive, set the base RPM to 1350 and set the accel rate to 9hz/second. This will give the closest approximate operation to units that do not have the drive.

Set Parameter 40 to 0.1, P41 to 5.0, P42 to 0.25, P45 to 0.25, P46 to 0.15, P47 to 0.6. See Figure 47.

2. Start the line with the cage controller off
3. Manually get the bubble to a size that allows you to increase and decrease (middle size).
4. Make sure the actual layflat is accurate. If it is not accurate to within 0.25 inches, recalibrate and recheck.

5. Set the cage controller to AUTO CAGE
6. Run the following bank of size change tests – in each case observe operation of the system. Look for no more than one overshoot. The objective is completely unattended size changes (with the exception of changes that require changes to air ring or cage height settings). The screen shows a graph window of 8 minutes. You should be able to get most unattended changes complete in less than 8 minutes. Also keep in mind, that size change time is linear. The more change you want, the more time it takes. You will not be successful in getting all size changes to complete in a fixed amount of time. Proceed through the table only as a step is successful. If you can't succeed with a small step then there is no point in proceeding. As a general rule size increases are always completed quicker than the comparable size decrease.

Change Target Setpoint By	Expected Action	Adjustments
1. Increase by a value just less than ½ of the layflat controller operation window (P97). For most lines this will be a value of 4.00 inches. So increase the layflat by something just less than 2.00 inches. Make sure cage height is correct so no change is made during the test.	System should go into contact mode and make the necessary adjustments until layflat is within the deadband setting (P42). Note that when in Contact mode the loop update time is 3 times the value specified in parameter 41.	Objective is to have system complete the task without losing bubble stability. If you have the layflat controller gain adjusted very high, the bubble may want to bulge outside the cage. Consider turning it down a little. If total time to complete is more than 5 minutes, then reduce the update time in steps of .25 seconds.
2. Decrease by the same value as step 1.	System should behave similarly except it should close the cage. If the layflat controller is set to an aggressive value, the bubble will lose size before the cage moves. This is normal.	Same objective. If it appears that the system is pausing a lot (watch the PID mode indicator), then you may have the oversize parameter (P45) set too small. Try increasing it by 0.125 inches. If the bubble is blowing out just below the cage, then the oversize limit needs to be decreased.
3. Two Step Test. Increase setpoint by a value double that of step 1. Typically this will be 4-5 inches.	System will first go into Forecast Mode. Also note the Deadband is automatically widened to a value equal to parameter 42 plus 1.00 inches. On the graph the layflat value will immediately drop down and the cage will begin to open. You will also see that the PID setpoint increased only ½ of P97 (layflat control window). This is done to keep the cage close to the cage at all times. After the film reaches the intermediate setpoint, the setpoint	This is called the two step test, because this size change requires the system to break down the request into to two steps. The forecast mode is used for the first time on this step. The maximum pulse (P47) is important to set properly for this step to function. Generally, if max pulse is set too high, you will get a fairly large overshoot. Reduce by steps of 0.1 seconds but do not go down below 0.4 seconds. If this does not help then you have to

	will change to the final setpoint. After the final setpoint has been reached (within the widened deadband), contact mode will take over and the rest of the process should resemble the operation of step 1. If step 1 was not completed properly, this step will not function properly.	increase the update time by 1 second.
4. Two Step Test. Decrease setpoint by a value double that of step 1. Typically this will be 4-5 inches.	This should perform the same as the above, but slightly slower. Again, watch the oversize control. It is okay to this activate. It is not ok for it to stop the process altogether.	
5. Multiple Steps Test. Increase setpoint by double that of step #3. Typically this will be 8-10 inches. You may need to change cage height slightly at the end of this test.	This tests breaking down the size change into 4 or more steps. You are looking for a stable bubble during the whole process.	Generally, there should be nothing to adjust. If you got this far, then it should function properly.
6. Multiple Steps Test. Decrease setpoint by double that of step #3. Typically this will be 8-10 inches. You may need to change cage height slightly at the end of this test.	This should perform the same as the above, but slightly slower. Again, watch the oversize control. It is okay to this activate. It is not ok for it to stop the process altogether.	
7. Big Multiple Steps Test. Increase setpoint to a value near the maximum allowed setpoint. Remember to check the system maximum layflat to make sure it is an inch or two more than the physical maximum.	This should perform similar to step #5, but about double the time.	
8. Big Multiple Steps Test. Decrease setpoint to a value near the minimum allowed setpoint. Remember to check the system minimum layflat to make sure it is an inch or two less than the physical minimum.	This should perform similar to step #6, but about double the time.	
9. Fully Automatic Startup Test. Set setpoint to most typical startup layflat. Start the line with cage controller on.	Cage will auto adjust to the required cage size. It is normal for it to go the wrong way during the first parts of startup. This is caused by bubble sway and is normal. It will not go far and will	

	recover without any problems. Note in this mode, the layflat controller does not help until the size gets within 4 inches (p97). At that time you will see a more pronounced move toward the target. If problems start after the layflat controller kicks in, you may have the layflat control gain set too high. If the system is very sluggish until it gets within the layflat control window, then the ABB startup ratio may be set too low or the ABB operating window may be too narrow.	

After all testing is complete, record all parameters with the handheld. Also record the manufacturer of the cage with the range of sizes that it can do. With a databank of cages, the need to perform this procedure should be reduced significantly.

Figures 48-53 show typical responses achieved during the tuning process. If one were to use a digital camera to photograph typical responses, they would look like these figures. Figure 48 shows a change from 73 inches to 75 inches in two steps. Figure 49 shows a size change from 75 inches to 67 inches in four steps.

Figure 50 shows a size change from 67 inches to 75 inches just as it starts; note the middle of the graph shows the size charge of 75 inches to 67 inches. Figure 51 shows a size change of 75 inches to 60 inches in seven steps.

Figure 52 shows a size change from 60 inches to 50 inches in five steps; note the end of the graph shows problems occurring with cage arms fitting each other and causing the cage to stick. Figure 53 shows a change from 50 inches to 75 inches, just as it is starting.

Parameters:* *The following are parameters which are available for operator input or use.

40 Minimum Pulse – this parameter has an available range of 0.1 to 1.0 seconds. However, this parameter should be set to 0.1 or 0.2 seconds. Setting the pulse width longer may cause the accuracy of the cage to be reduced somewhat. Use the Test Open and Close buttons to determine if the minimum pulse will actually move the cage.

41 Cage Update Time – this parameter has an available range of 1.0 to 8.0 seconds. It applies to the PID update time used in Forecast Mode. However, this value is multiplied by three when in contact mode. This is done to ensure the bubble has time to respond to the imposed change in size. For most systems this will be set to 5.0. If you see you are constantly squeezing the bubble too much (size changes of the cage are occurring faster than the bubble can respond), then slow down the cage speed or increase this value by 0.5-second increments).

42 Cage Controller Accuracy – this parameter is essentially the deadband of the cage controller PID loop. Start with 0.15 inches for most systems. Smaller values take longer to achieve. Do not go below 0.15 inches if the contactors are having problems with the 0.1 minimum pulse value (arcing). You can also increase the gain of the layflat controller to help compensate for this a bit – but only as a last resort since you have already tuned that system to a stable condition.

43 Cage Position – this is a read-only parameter you can see on the Cage Controller Parameters Screen 166 (CGSIZE). It is only meaningful when the system is in the Forecast Mode.

44 Stable Layflat Count – this is a read-only parameter that counts successive stable readings after the IBC sensor has become stable (echo on and high-speed filter completed). You can see it as a bar graph on the Cage Controller Monitor (Screen 163). The bargraph only goes to 50% by design. Once it gets to 50%, the cage controller will resume operation if it paused, or it will allow forecast mode to start if there is a condition requesting the cage controller start.

45 Oversize Limit – this parameter has a range of 0.12 to 1.50 inches. This controls how much oversize is allowed when moving the cage. If oversize limit is exceeded, then cage controller pauses until bubble is no longer oversize. When set properly, the bubble will rarely squeeze out below the cage. Recommended setting for this parameter is 0.25

46 Cage Control Change Threshold – This parameter has a range 0.01 to 1.00 inches. This control activates the cage controller in CONTACT mode (if Auto Cage is selected) when the operator changes the cage contact by more than the amount specified in this parameter. Typical value for this parameter is 0.05 inches.

47 Cage Control Max Pulse Time – This parameter has a range of 0.3 to 5.0 seconds. Typically this value should be set to 0.6 seconds for commissioning. The best starting point is to add 0.5 seconds to the minimum pulse value. So if the minimum pulse is 0.1 seconds, then set the maximum pulse to 0.6 seconds. If the layflat overshoots several times before settling, make sure you determine that the cage is overshooting and not just the layflat. If the layflat is overshooting, then it may be possible that the layflat controller gain is too high. If the cage is overshooting the position, check also the speed of the cage. Reduce the cage speed slightly and redo the test. Generally, the maximum pulse should not be less than 0.5 seconds; otherwise large size changes will take too long.

Although the invention has been described with reference to a specific embodiment, this description is not meant to be construed in a limiting sense. Various modifications of the disclosed embodiment as well as alternative embodiments of the invention will become apparent to persons skilled in the art upon reference to the description of the invention. It is therefore contemplated that the appended claims will cover any such modifications or embodiments that fall within the true scope of the invention.